State of Wisconsin/Department of Transportation

RESEARCH PROGRESS REPORT FOR THE QUARTER ENDING: September 30, 2008

Program: SPR-0010(36) FFY99	**Part: II Research and Development**
Project Title: Effective Depth of Soil Compaction in Relation to Applied Compactive Energy	**Project ID:** 0092-08-11
Administrative Contact: Nikki Hatch	**Sponsor:** Wisconsin Department of Transportation
WisDOT Technical Contact: Bob Arndorfer	**Approved Starting Date:** 10/7/07
Approved by COR/Steering Committee: $54,914	**Original End Date:** 4/7/07
Project Investigator (agency & contact): Dante Fratta & Haifang Wen- University of Wisconsin-Madison	**Current End Date:** 4/7/09 **Number of Extensions:** 0

Percent Complete: 50%

Request a No Cost Time Extension (Please Select One): [ ] YES [X] NO

Reason for No Cost Time Extension: None

Project Description:

The determination of the appropriate lift thicknesses used in embankment construction operations has important economic and engineering implications in the design and construction of roads, levees and dams. For example, small lift thicknesses may cause excessive construction costs while large lift thicknesses may reduce the compaction effectiveness and compromise the integrity of the embankment. This research proposal will use experimental results and numerical analyses to evaluate the effective depth of compaction. These results and analyses will provide the engineering understanding of the problem and justify recommendations about maximum lift thickness to be used in WisDOT embankment construction projects.

This proposed research program will collect data and develop analyses needed to determine optimum lift thickness for WisDOT embankment construction projects. The results will establish a relationship between the applied compaction energy and the level of compaction achieved at increasing depths for a number of different soils and moisture contents. The data, analyses, and correlations will help WisDOT officials in proposing possible revisions to current constructions specifications including the need to change the established 8-in lift thickness in the construction of compacted embankments. The successful completion of this research will also help WisDOT officials in improving construction operations by creating more stable and economical subgrade structures.

Progress This Quarter

During this quarter, the research team completed the field data collection (July 8-10 and July 14-17, 2008) at the Hoffman construction site near Junction City. The research team has begun data reduction and interpretation.

Field Compaction Equipments

The test sections were compacted using the three types of compaction equipment as planned: rubber-tired roller (dozer), smooth-drum vibratory roller, and sheepsfoot roller. In addition, to examine of the compacting ability of the heavy loaded scraper, the additional measurement tests with scraper were conducted for thick lift-thickness sections.


Rubber-tired Roller (Dozer)

Smooth-drum Vibratory Roller


Sheepsfoot Roller


Scraper

Field Testing:

The field work with moisture control (three types of moisture contents near the optimum water content) as planned could not be conducted due to lack of time. For fine grained soil, only one moisture content was tested (same as actual field construction moisture). For the coarse grained soil (sand), two moisture contents were tested, one is the constructing moisture content and the other is wetter than the actual constructing moisture content. The type and numbers of specific tests in the field work are summarized in following matrix:

1) Fine grained soil (near optimum moisture content)

Compactor	Lift-thickness	Measured parameters
Vibratory Roller	12 in	• MEMS particle acceleration and rotation (1 spot) • DCP (3 spots) • Pressure plate (1 spot) • TDR (3 spots) • SSG (8 spots) • Sand cone density(2 spots)
	17 in	• MEMS particle acceleration and rotation (1 spot) • DCP (3 spots) • Pressure plate (1 spot) • TDR (3 spots) • SSG (13 sports) • Sand cone density (2 spots)
	24 in	• MEMS particle acceleration and rotation (1 spot) • DCP (1 spot) • Pressure plate (1 spot) • TDR (4 spots) • SSG (9 spots) • Nuclear density gauge (1 spot)
Rubber-tired Roller	8~11 in	• MEMS particle acceleration and rotation (2 spots) • DCP (4 spots) • Pressure plate (1 spot) • TDR (7 spots) • SSG (11 spots) • Sand cone density (2 spots)
	20 in	• MEMS particle acceleration and rotation (1 spot) • DCP (3 spots) • Pressure plate (1 spot) • TDR (3 spots) • SSG (4 spots) • Sand cone density (2 spots)
Sheepsfoot Roller	10~16 in	• MEMS particle acceleration and rotation (2 spots) • DCP (6 spots) • Pressure plate (1 spot) • TDR (8 spots) • SSG (8 spots) • Sand cone density (3 spots)
	20 in	• MEMS particle acceleration and rotation (1 spot) • DCP (1 spot) • Pressure plate (1 spot) • TDR (3 spots) • SSG (3 spots) • Nuclear density gauge (1 spot)
Scraper	24 in	• MEMS particle acceleration and rotation (1 spot) • DCP (3 spots) • Pressure plate (1 spot) • TDR (3 spots) • SSG (8 spots) • Nuclear density gauge (1 spot)

2) Coarse grained soil (sand - near optimum moisture content)

Compactor	Lift-thickness	Conducted tests
Vibratory Roller	8 in	• MEMS particle acceleration and rotation (2 spots) • DCP (1 spot) • Pressure plate (1 spot) • TDR (8 spots) • SSG (6 spots) • Sand cone density (1 spot)
	13 in	• MEMS particle acceleration and rotation (2 spots) • DCP (1 spot) • Pressure plate (1 spot) • TDR (9 spots) • SSG (6 spots) • Sand cone density (2 spots)
	24 in	• MEMS particle acceleration and rotation (2 spots) • DCP (1 spot) • Pressure plate (1 spot) • TDR (10 spots) • SSG (10 spots) • Sand cone density (3 spots)
Rubber-tired Roller	8 in	• MEMS particle acceleration and rotation (2 spots) • DCP (1 spot) • Pressure plate (1 spot) • TDR (6 spots) • SSG (8 spots) • Sand cone density (1 spot)
	13 in	• MEMS particle acceleration and rotation (2 spots) • DCP (1 spot) • Pressure plate (1 spot) • TDR (6 spots) • SSG (8 spots) • Sand cone density (2 spots)
	20 in	• MEMS particle acceleration and rotation (2 spots) • DCP (1 spot) • Pressure plate (1 spot) • TDR (8 spots) • SSG (8 spots) • Sand cone density (3 spots)
Scraper	13 in	• MEMS particle acceleration and rotation (2 spots) • DCP (1 spot) • Pressure plate (1 spot) • TDR (8 spots) • SSG (8 spots) • Sand cone density (2 spots)
	23 in	• MEMS particle acceleration and rotation (2 spots) • DCP (3 spots) • Pressure plate (1 spot) • TDR (8 spots) • SSG (8 spots) • Sand cone density (2 spots)

3) Coarse grained soil (sand - wetter than optimum moisture content)

Compactor	Lift-thickness	Conducted tests
Vibratory Roller	8 in	• MEMS particle acceleration and rotation (2 spots) • DCP (1 spot) • Pressure plate (1 spot) • TDR (8 spots) • SSG (8 spots) • Sand cone density (1 spot)
	13 in	• MEMS particle acceleration and rotation (2 spots) • DCP (1 spot) • Pressure plate (1 spot) • TDR (8 spots) • SSG (8 spots) • Sand cone density (1 spot)
	23 in	• MEMS particle acceleration and rotation (2 spots) • DCP (1 spot) • Pressure plate (1 spot) • TDR (8 spots) • SSG (8 spots) • Sand cone density (2 spots)
Rubber-tired Roller	13 in	• MEMS particle acceleration and rotation (2 spots) • DCP (1 spot) • Pressure plate (1 spot) • TDR (8 spots) • SSG (8 spots) • Sand cone density (2 spots)
	23 in	• MEMS particle acceleration and rotation (2 spots) • DCP (1 spot) • Pressure plate (1 spot) • TDR (8 spots) • SSG (8 spots) • Sand cone density (2 spots)

Note: Nuclear density tests (CPN MC-3 Portable) of 3 spots were conducted in cooperation with Hoffmann Construction Company. A parenthesis indicates the number of testing. The abbreviation indicates followings: MEMS (Miniature Electro-Mechanical Systems), DCP (Dynamic Cone Penetrometer), TDR (Time Domain Reflectometry), SSG (Soil Stiffness Gauge).

Work Next Quarter:

During the fifth quarter, the research team will finalize data reduction and interpretation. The research team will begin the interpretation of the data with numerical modeling and analysis to evaluate appropriate lift thicknesses used in embankment construction operations.

Circumstances Affecting Progress/Budget:

None

Gantt Chart:

Phase Number	1.5 Years (18 months)					
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 5	Quarter 6
Phase I						
Phase II						
Phase III						
Phase IV						
Phase V						